PD-0455

Combined T2w volumetry, DW-MRI and DCE-MRI for response assessment after chemoradiation in rectal cancer

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Purpose/Objective: Organ sparing treatment is gradually becoming an option for patients with locally advanced rectal cancer (LARC) with good clinical response after neo-adjuvant chemoradiation (CRT). However, patient selection for organ sparing treatment is challenging and there is no standard of care restaging procedure after CRT. Functional MR imaging, diffusion weighted MRI (DW-MRI) and dynamic contrast enhanced MRI (DCE-MRI) showed promising results in earlier studies. In this study, we assessed the value of combined T2 weighted MRI (T2w) volumetry, DW-MRI and DCE-MRI for pathological response prediction after neo-adjuvant CRT in patients with LARC.

Materials and Methods: Patients received MRI with DW-MRI and DCE-MRI sequences before start of CRT and before surgery. After surgery, the tumor regression grade (TRG) was obtained based on the score by Mandard et al. Pathological complete responders (pCR, Mandard 1) were compared with non-pCR patients. Besides, patients with a good response, GR (Mandard 1+2) were compared with patients with a non-GR.

Results: From the 55 patients analyzed in the study, six showed a pCR (10.9%) and 10 had a GR (18.6%). Favorable responders had a larger decrease in tumor volume, a larger increase in Apparent Diffusion Coefficient (ADC) values and a larger decrease in Ktrans compared to non-responders. ADC change showed the best accuracy for diagnoses of pCR. For GR, the model including ADC change and volume change showed the best diagnostic performance. Inclusion of Ktrans change did not increase the diagnostic values for pathological favorable response.

model	pCR						GR					
	AUC	Accuracy	Sensitivity	Specificity	PPV	NPV	AUC	Accuracy	Sensitivity	Specificity	PPV	NPV
Δvolume	0.81	78%	83%	78%	31%	97%	0.84	82%	80%	82%	50%	95%
ΔADC	0.93	95%	83%	96%	71%	98%	0.97	95%	80%	98%	89%	96%
ΔKtrans	0.80	87%	67%	90%	44%	96%	0.86	91%	60%	93%	67%	91%
Δvolume ΔADC ΔKtrans	0.95	93%	67%	96%	67%	96%	0.99	98%	90%	98%	90%	98%
Δvolume ΔADC	0.95	93%	67%	96%	67%	96%	0.99	98%	90%	98%	90%	98%
Δvolume ΔKtrans	0.90	94%	50%	94%	50%	94%	0.93	89%	50%	98%	83%	90%
ΔADC ΔKtrans	0.93	93%	50%	98%	75%	94%	0.98	95%	90%	96%	82%	98%

Table 1: Diagnostic values for the diagnosis of pathological complete response (pCR) and pathological good response (GR) for the different models. In the individual parameter models the optimal cut-off values for Δvolume, ΔADC and ΔKtrans were -74%, +44% and -32%, respectively. Abbreviation: ADC = apparent diffusion coefficient, AUC = area under the receiver operating curve, PPV = positive predictive value and NPV = negative predictive value.

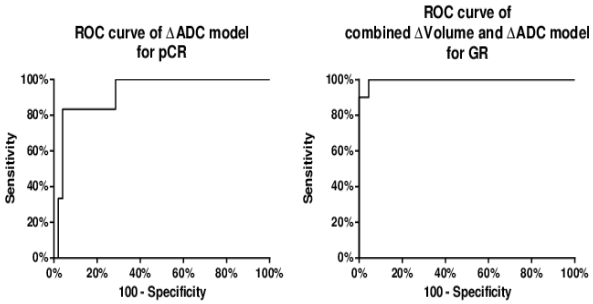

Figure 1: receiver operating characteristic (ROC) curves for models with the best diagnostic accuracy for pathological complete reseponse (pCR, left) and pathological good response (GR, right).

Conclusions: This explorative study showed that ADC decrease is a promising diagnostic tool for pCR and the combination of ADC and volume decrease for GR in patients with LARC after neo-adjuvant CRT. Ktrans change showed no additional value. These results justify further research in a larger prospective study with DW-MRI and tumor volumetry.

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Robustness of three stoichiometric CT-calibration parameterizations used in proton therapy

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Purpose/Objective: The use of a stoichiometric CT-calibration has become the standard method for converting CT-numbers to relative proton stopping-power-ratios (SPR) worldwide. However, several different parameterizations for the calibration have been published and the aim of this project is to assess accuracy and robustness of the CT-calibration for three different parameterizations.

Materials and Methods: Phantom model 062M from CIRS (Norfolk, VA, USA) with a fixed distribution of inserts with known mass density and elemental composition was scanned daily over a period of two months with a 120 kVp clinical protocol on a Siemens Definition AS+ to determine the variation of the CT-numbers. Repeated calibration scans with the inserts positioned centrally in a homogenous phantom, one by one, were performed to determine stable mean CT-numbers.Three published stoichiometric parameterizations using 1, 2 or 3 fitting parameters were evaluated by simulating random changes in the measured mean CT-numbers based on the measured variation. CT-numbers for 72 theoretical tissue compositions were then calculated for each simulation. The resulting mean values and SD were plotted against their Bethe-Bloch calculated SPR for 100 MeV protons. Finally the mean-calibration curve was determined for each parameterization using piecewise connection of weighted linear regressions within each tissue group.

Results: The measured SD for the inserts was 1-5 HU (mean SD 2.7 HU). 10000 simulations of the stoichiometric calibration were performed for each parameterization, using a normal distribution with the measured mean values and a standard deviation of 3 HU for the inserts. The resulting RMSE was similar between the three methods for all simulations. For each method the resulting mean-calibration curve is plotted in Figure 1a together with the mean CT-number and SD (horizontal error bars) for the 72 theoretical tissues. The curves from the methods using 2 and 3 fitting parameters are more or less inseparable throughout the whole CT-range, whereas the 1-fitting parameter method differ somewhat in the dense bone region. The largest disagreement is 18 HU for cortical bone (#72). This corresponds to 0.6% difference in SPR for a HU of 1200. The SD of the calculated CT-numbers is presented separately in Figure 1b. The method using 3 fitting parameters have significantly larger SD compared to the other two methods, especially for bony tissues.